भारतीय मानक

Indian Standard

IS 13129 (Part 4) : 2023

सौर तापन — पानी गर्म करने की घरेलू प्रणाली

भाग 4 टिकाऊपन और विश्वसनीयता ज्ञात करना

(पहला पुनरीक्षण)

Solar Heating — Domestic Water Heating Systems

Part 4 Determination of Durability and Reliability

(First Revision)

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BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

August 2023 **Price Group 5**

Renewable Energy Sources Sectional Committee, MED 04

FOREWORD

This Indian Standard (Part 4) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Renewable Energy Sources Sectional Committee had been approved by the Mechanical Engineering Division Council.

A wide variety of Solar Domestic Hot Water (SDHW) systems are marketed throughout the world. A natural consequence of this highly dispersed activity is the need to understand, predict and compare the performance of these systems. Standardized test methods are essential for assessing the performance potential. This standard has been developed to facilitate the comparison of these systems.

Because of the various testing methodologies for determining thermal performance are being followed and acceptance in the industry, it was decided to prepare separate parts of this standard each covering a separate methodology.

This standard was first published in 1991. The present revision has been taken up with a view to incorporating the modifications found necessary as a result of experience gained on the use of this standard. Also, in this revision, the standard has been brought into the latest style and format of Indian Standard, and references to Indian Standards, wherever applicable have been updated.

Other parts of the standard under the general title ‘Solar heating — domestic water heating system’ are:

Part 1 Performance rating procedure using indoor test methods
Part 2 Procedure for system performance characterization and yearly performance predication
Part 3 Procedures for system component characterization and predication for yearly performance using component performance data

The composition of the committee responsible for the formulation of this standard is listed in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SOLAR HEATING — DOMESTIC WATER HEATING SYSTEMS

PART 4 DETERMINATION OF DURABILITY AND RELIABILITY

(First Revision)

1 SCOPE

1.1 This standard establishes uniform methods of testing solar domestic water heating systems for short term durability and reliability.

1.2 This standard establishes specific safety and health requirements.

1.3 This standard applies to solar domestic heating systems designed to heat water for domestic usage.

1.4 This standard does not contain test methods to evaluate the reliability and durability of specific components or component materials used in solar water heating systems.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
IS 12933 (Part 5) : 2003	Solar flat plate collector — Specification: Part 5 Test methods (*second revision*)

3 DEFINITIONS

3.1 Absorber — Device within a collector for absorbing radiant energy and transferring this energy as heat into a fluid.

3.2 Ambient Air — Air in the space (either indoors or outdoors) surrounding the thermal energy storage device or solar collectors, whichever is applicable.

3.3 Angle of Incidence (of Direct Solar Radiation) — The angle between the solar radiation beam and the outward drawn normal from the plane considered.

3.4 Auxiliary Thermal (Heat) Source — A source of thermal energy, other than solar, used to supplement the output provided by the solar energy system; usually in the form of electrical resistance heat or thermal energy derived from combustion of fossil fuels.

3.5 Close-Coupled Solar Water Heater — A unit where the collector abuts the container on a common chassis or cradle.

3.6 Collector — A device containing an absorber.

3.7 Components — Parts of the solar hot water system including but not limited to collectors, storage, pumps, heat exchanges, controls, etc.

3.8 Control — Any device for regulation of the solar thermal system or component in normal operation, can be manual or automatic.

3.9 Domestic — Refers to use in residential and small commercial buildings.

3.10 Emittance — The ratio of the radiant energy emitted by a body to the energy emitted by a black body at the same temperature.

3.11 Forced Circulation System — A system which utilizes mechanical means requiring external power to circulate the heat transfer fluid through the collector(s).

3.12 Heat Exchanger — A device specifically designed to transfer heat between two physically separated fluids. Heat exchangers can have either single or double walls.

3.13 Heat Sink — A device for absorbing thermal and radiant energy.

3.14 Heat Transfer Fluid — A fluid that is used to transfer thermal energy between components in a system.

3.15 Integral Collector-Storage System — A system which has the storage within the collector, directly exposed to the solar irradiance.

3.16 Pyranometer — Instrument for measuring the radiation on a plane receiver surface which results from the radiant fluxes incident from the hemisphere above within the wavelength range 0.3 µm and 3 µm.

3.17 Serviceability — The capability of a device or system of remaining usable for an intended function.

3.18 Solar Collector — *See* **3.19**.

3.19 Solar Thermal Collector — A device designed to absorb solar radiation and to transfer the thermal energy so gained to a fluid passing through it.

3.20 Solar Radiation — The radiation emitted by the sun. Practically all of the solar radiation incident at the earth's surface is at wavelengths less than 3 µm and is often termed 'short wave radiation'.

3.21 Solar Irradiance Simulator — An artificial source of radiant energy simulating the solar radiation, usually an electric lamp or an array of such lamps.

3.22 Solar Hot Water System — The complete assembly of subsystems and components necessary to convert solar energy into thermal energy for the heating of water. It may include an auxiliary heat source.

3.23 Storage Device (Thermal) — The container(s) plus all contents of the container(s) used for storing thermal energy.

NOTE — The heat transfer fluid and accessories such as heat exchangers, flow switching devices, valves, and baffles which are firmly fixed to the thermal storage container(s) arc considered a part of the storage device.

3.24 Thermosiphon System — A system which utilizes only the change in density of the heat transfer fluid in the collector relative to the storage or heat exchanger to cause circulation of fluid between the collector and storage or heat exchanger.

3.25 Water Draw Rate — The rate at which the hot water is withdrawn from the system at a specified time.

4 FREEZE PROTECTION TESTS

This freeze protection test is applicable to solar water heating systems in which water without antifreeze additives circulates through the solar collector or other system components that are normally exposed to outdoor weather conditions.

4.1 Purpose

The purpose of this test is to determine if the solar water heating system will withstand freezing conditions without damage to the system at the minimum ambient air temperature specified by the manufacturer.

4.2 Apparatus

The following apparatus is required:

a) An insulated chamber large enough to enclose all parts of the system which would be exposed outdoors, including a minimum of 2 m of water supply piping and 2 m of return water piping;

b) A stand on which collectors of the maximum area recommended by the manufacturer (or the complete unit in the case of a close coupled solar water heater) can be installed at the recommended angle of inclination;

c) A heat sink of a minimum area equal to the maximum collector array area that can be tested mounted horizontally at least 1 m above the highest point of the collector array. The temperature of the heat sink shall be controlled independently of the chamber. The underside of the heat sink shall have an emittance of not less than 0.95 and the top surface shall be insulated so as to minimize its air temperature cooling effect;

d) A means of cooling the air in the chamber at a controlled rate to the minimum required temperature and maintaining a uniform temperature within 3 °C around the four sides, the top and the bottom of the collector and other components;

e) A means of heating the air in the chamber at a controlled rate to a maximum temperature of 30 °C;

f) Temperature measuring devices to measure the ambient air temperature on the four sides, the top and the bottom of the collector and other components, the temperature of the heat sink and the temperature of the water at the inlet and outlet of the collector array, or that portion of the system within the chamber;

g) A temperature and pressure controlled water supply within the range of 5 °C to 25 °C and 200 kPa to 600 kPa or the manufacturer's maximum working pressure whichever is less; and

h) A means of measuring the volume of any water discharged from freeze protection valves.

4.3 Procedure

The procedure shall be as follows:

a) Install the solar water heating system according to manufacturer's instructions such that the collectors and other components normally exposed to the outdoors are inside the insulated chamber. Unless otherwise specified in the installation instructions, install a minimum of 2 m of water supply piping and 2 m of return water piping inside the insulated chamber;

b) Charge the system with cold water and for pressurized storage tanks maintain the water supply pressure;

c) Energize the system as specified by the manufacturer, including any freeze protection equipment, but not including any auxiliary thermal sources;

d) Reduce the ambient air temperature in the chamber to 8 °C ± 2 °C and maintain this temperature for 1 h;

e) Following this one hour period, simultaneously commence cooling the chamber at a uniform rate not exceeding 5 °C per hour down to the manufacturer's specified minimum temperature and cooling the heat sink to a temperature 20 °C ± 2°C below the specified minimum temperature;

f) Maintain the chamber and heat sink at these minimum temperatures for a period of 12 hours or until the temperature of the water at the inlet and outlet of the collector array or that portion of the system within the chamber has stabilized to a rate of change less than 0.25 °C for one hour;

g) Simultaneously begin raising both the temperature of the chamber at a uniform rate not exceeding 5 °C per hour and the heat sink to a temperature of 30 °C ± 2 °C;

h) Maintain the chamber and heat sink at a temperature of 30 °C ± 2 °C for a period of 2 hours;

j) For those systems that have pumps and/or drain-down valve controllers activated by solar radiation or a timer, the controls shall be activated manually or otherwise for a period of 1 h while maintaining the chamber and heat sink at a temperature of 30 °C ± 2 °C;

k) Repeat steps (e) to (j) five times;

m) Repeat steps (e) and (f) once;

n) For those systems that are seasonally operated and must be drained manually when ambient air temperatures fall below the specified minimum temperature, drain the system as specified by the manufacturer and, reduce the temperature in the chamber to 15 °C ± 2 °C below the specified minimum temperature and maintain for a period of 12 h or until the temperatures at the inlet and outlet of the collector array or that portion of the system within the chamber has stabilized to a rate of change less than 0.25 °C for one hour;

p) Purge the atmosphere within the chamber with fresh air at room temperature and open the chamber. Examine the system for evidence of freeze damage or leakage;

q) Isolate the water supply and relieve the water pressure in the system as necessary. Disconnect the piping connections to the Collector, the water supply piping and the return water piping and examine the pipework, collectors and other components inside the chamber for any ice formation; and

r) If there is no indication of leakage or other damage, re-assemble the pipework and subject the system to a hydrostatic pressure test as per **6**.

4.4 Safety Precaution

The use of a cryogenic fluid (for example, liquid nitrogen) may be a suitable means of providing the low temperature conditions necessary for this test. However, attention must be given to the safety precautions necessary when handling and storing cryogenic fluids.

4.5 Reporting Requirements

The following results shall be reported:

a) The make and model identification of the system including ancillary freeze protection devices fitted;

b) The inclination of the collector array;

c) A record of all measured temperatures versus time during the test period;

d) A record of the time of activation of any pumps, valves or other electrical or mechanical devices;

e) The volume of water discharged out of the system through freeze protection values;

f) Evidence of any ice formation in the collectors, pipework or other components inside the chamber; and

g) Details of the condition of the system following the test with particular regard to defects which affect the serviceability of the system such as the swelling of pipes and components or leakages shown by the hydrostatic pressure test.

NOTE — If ice formation is evident in the collectors, pipework or other components inside the chamber, further testing outside the scope of this standard may be necessary to determine the durability of the particular components to repeated freezing conditions.

5 OVER TEMPERATURE AND SCALD PROTECTION TEST

This test may be conducted using a solar simulator or outdoors.

5.1 Purpose

The purpose of this test is to determine whether the solar water heating system is adequately protected against damage and the user is protected from scalding hot water delivery after a period of no hot water draw and failure of electrical power.

5.2 Apparatus

The following apparatus is required:

a) A pyranometer to measure the total short wave radiation from both the sun and the sky or the short wave radiation from a solar simulator lamp if the test is to be conducted inside a solar simulation chamber;

b) Equipment to measure the temperature, flow rate and volume of hot water drawn from the system;

c) An outdoor or an indoor test stand for installing the solar hot water system with the collector array at the manufacturer's specified angle of inclination; and

d) A temperature and pressure controlled water supply within the range of 5 °C to 25 °C, and 200 kPa to 600 kPa or the manufacturer's maximum working pressure whichever is less.

5.3 Procedure

The procedure shall be as follows:

a) Assemble the solar water heating system according to the installation instructions with the collector array oriented towards solar noon for the outdoor test, or the simulator lamp may be adjusted to normal incidence for the indoor test;

b) Charge the system for the water supply and for pressurized storage tanks maintain the water supply pressure;

c) Energize the system as per installation instructions;

d)
   1) For the outdoor test, operate the system for a minimum of 4 consecutive days without any hot water withdrawal and until the collector array has been subjected to 2 consecutive days in which the total solar radiation on the plane of the collector array has exceeded 20 MJ/m^2 over an 8 h period each day and the ambient temperature has exceeded 20 °C during solar noon.
   2) For the indoor test, operate the system without any hot water withdrawal at a minimum ambient temperature of 25 °C and a minimum solar lamp intensity of 1 000 W/m^2 at the plane of the collector array, measured and with a uniformity for an 8 h period or until the collector array drains;

e)
   1) For the outdoor test, disconnect all electrical power to the system and continue to operate the system until the total solar radiation on the plane of the collector array has exceeded 20 MJ/m^2 over an 8 h period or until the collector array drains; and
   2) For the indoor test, disconnect all electrical power to the system and subject the system to a minimum solar lamp intensity of 1 000 W/m^2 at the plane of the collector array for an additional 4 h or until the collector array drains; and

f) Immediately begin to withdraw a volume of water greater than the total volume of water in the system at a rate of 12 litre/min ± 2 litre/min.

5.4 Reporting Requirements

The following results shall be reported:

a) The make and model identification of the system including ancillary scald and over temperature protection devices fitted;

b) The inclination of the collector array;

c) A record of temperature of the hot water withdrawn from the system versus time and the total volume of water withdrawn; and

d) Details of the condition of the system and individual components following the test or any failure modes during the test with particular regard to any defects which may affect the serviceability of the system such as the swelling of pipes and components, or fluid leakages.

6 PRESSURE TEST

6.1 Purpose

The purpose of this test is to evaluate hydraulic pressure rating of all components and interconnections of a solar water heating system when installed according to the manufacturer's instructions.

6.2 Apparatus

The apparatus shall consist of the following:

a) A suitable platform and support structure for installation of the system;

b) A pressure regulated hydraulic pressure source;

c) A pressure gauge suitable to determine the test pressure to within 1 percent;

d) A bleed valve; and

e) An isolation valve.

6.3 Safety Precaution

This test procedure requires the use of hydraulic pressure up to a possible pressure of 2 000 kPa. An explosion safe enclosure is recommended when testing systems that have an integral expansion space or tank that contains entrapped air.

6.4 Procedure

a) Install the solar water heating system on the test platform in accordance with the manufacturer's instructions;

b) Tie down the pressure relief valves to prevent their opening during testing;

c) Connect the pressure gauge and bleed valve at the hot water outlet of the system;

d) Connect the isolation valve and hydraulic pressure source, using water as the test fluid, to the cold water inlet of the system. The water shall be kept at a temperature of 15 °C ± 2 °C;

e) Fill the potable water side of the system using the hydraulic pressure source and bleed all air, as possible, out of the system through the bleed valve at the hot water outlet of the system;

f) Apply a hydraulic pressure equal to either the manufacturer’s stated maximum test pressure, or 1.5 times the manufacture’s stated maximum working pressure, whichever is the lesser;

g) Isolate the pressure source by closing the isolation valve and record the readings of the pressure gauge at the beginning and end of the next 15 minute interval;

h) Release the system pressure through the bleed valve and record any visible permanent deformation and water leakage from system components and inter connections;

j) Disconnect the bleed valve, pressure gauge, isolation valve and hydraulic pressure source from the system;

NOTE — For those systems which are not constructed with a heat exchanger and a separate pressurized heat transfer loop, the following procedural steps are to be omitted.

k) Connect the bleed valve and pressure gauge to the drain port of the system’s heat transfer loop and connect the isolation valve and hydraulic pressure source, using the manufacturer’s stated heat transfer fluid, to the fill port of the heat transfer loop;

m) Fill the heat transfer loop of the system using the hydraulic pressure source and bleed all air, as possible, out of the loop through the bleed valve at the drain part of the top of the collector array;

n) Apply a hydraulic pressure equal to either the manufacturer’s stated maximum test pressure, or 1.5 times the manufacturer’s stated maximum working pressure for the heat transfer loop, whichever is the lesser;

p) Isolate the pressure source by closing the isolation valve and record the readings of the pressure gauge at the beginning and end of the next 15 minute interval; and

q) Release the system pressure through the bleed valve and record any visible permanent deformation and heat transfer fluid leakage from system components and interconnections.

6.5 Reporting Requirements

Report the maximum test pressure applied, the pressure readings at the beginning and end of the 15 minute test intervals and any visible permanent deformation of leakage from system components and interconnections. Note if the applied test pressures are lower than 1.5 times the manufacturer’s stated maximum working pressure.

7 COLLECTOR QUALIFICATION TESTS

The collector qualification tests of IS 12933 (Part 5) applicable to systems with integral storage or close-coupled storage.

8 HEALTH AND SAFETY REPORTING REQUIREMENTS

8.1 Purpose

The purpose of the health and safety reporting requirements is to provide technical information concerning the protection from excessive temperatures, pressures and potable water contamination.

8.2 Reporting Requirements

The following technical information is to be reported from the visual observation of the markings on the equipment supplied by the manufacturer or from the manufacturer’s product specification documentation:

a) Pressure relief valves
   1) Location of valve;
   2) Pressure relief rating in kPa;
   3) Thermal discharge rating in kW; and
   4) Certification marks.
b) Temperature relief valves
   1) Location of valve;
   2) Temperature relief rating °C;
   3) Thermal discharge rating in kW; and
   4) Certification marks.
c) Heat exchangers
   1) Type of heat exchanger that separates the potable water from the collector heat transfer loop;
   2) Composition of the wall material(s) of the heat exchanger;
   3) Composition of the heat transfer fluid(s) specified by the manufacturer; and
   4) The maximum working pressure of the collector heat transfer loop.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Renewable Energy Sources Sectional Committee, MED 04

Organisation	*Representative(s)*
Ministry of New And Renewable Energy, New Delhi	DR A. K. TRIPATHI **(*Chairperson*)**
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In Personal Capacity, (*C*-103 *A, JVTS Garden Chaterpur Extension, New Delhi* 110074)	Shri Atam Kumar
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Scientist ‘B’/Assistant Director
(Mechanical Engineering), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402
Website: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093	2821 8093

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